

**PHASAL STATE OF *SCHISTOCERCA GREGARIA* FORSKAL, 1775  
(ORTHOPTERA, ACRIDIDAE) IN THE BREEDING BIOTOPES OF  
ALGERIAN SAHARA DURING 2009 AND 2010**

**BENSAAD H<sup>1</sup> & DOUMANDJI-MITICHE B<sup>2</sup>**

<sup>1</sup>National Institute of Plant Protection, Algiers, Algeria

<sup>2</sup>Department of Agricultural and Forestry Zoology, Agronomical Upper National School, El-Harrach, Algeria

**ABSTRACT**

To better understand the trend of locust populations existing in southern Algeria during the calm periods (recession), a study on the phase status of locust populations of *Schistocerca gregaria* in its natural biotope, was carried out during the two years 2009 and 2010. To do this, morphometric measurements of 163 Locust individuals including 81 males and 82 females, from eight different biotopes, were performed. The mean values of morphometric ratios of Elytron on Femur (E / F) and Femur on Cephalic capsule (F / C) in the 8 study sites fluctuate in males from 2.02 to 2.13 for the E / F ratio and 3.65 to 3.95 F / C ratio. For females E / F varies between 2.09 to 2.15 and F / C varies between 3.83 to 4.03. The comparison of the results related to E / F ratios and F / C with those of Dirsh (1953) and the report on their morphometric abacus of Duranton and Lecoq (1990) showed that male and female populations that evolve in the biotopes of both southern and central parts of the Algerian Sahara, for the two years 2009/2010 are mostly the Solitarious-transient with a rare presence of purely solitary individuals and a total absence of gregarious individuals.

**KEYWORDS:** *Schistocerca gregaria*, Morphometry, Biotopes, Phasal State

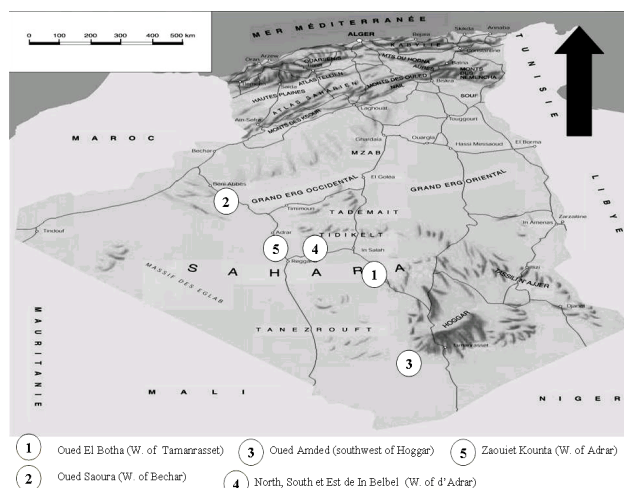
**INTRODUCTION**

Algeria, as the countries sheltering breeding areas of the locust *Schistocerca gregaria*, faces every year a risk of invasion of this species. The Locust *Schistocerca gregaria* is an insect which is able, under influence of biotic and abiotic factors, being transformed from a harmless solitary phase to a very voracious and gregarious phase. This transformation takes place through intermediate phases, called transient, resulting in morphological changes, pigment and anatomical. Morphometric indices are one of the indicators that provide information on the trend of locust populations to one or to the other of the two phases. Indeed, under the effect of the grouping, the body parts of hoppers and adults, don't grow all in the same sizes.

This is why, the morphometric measurements are often used to characterize the phases of locusts (Uvarov, 1928 Dirsh, 1953) in (Duranton and Lecoq, 1990). Gregarious locusts are characterized by a higher E / F and a lower F / C compared to solitary. Indeed, in solitary locusts, F / C is higher and E / F lower compared to gregarious (Meinzingen, 1993) in (Moumen, 2002). Given that in Algeria only few studies have been addressed on the phasal state locusts in the recession period in the Sahara, we considered it useful to carry out this work to better understand the behavior of the locusts in the field during recession periods.

Our study was performed on individuals of *Schistocerca gregaria* coming from the field (natural environments)

captured in the different regions of the Algerian Sahara during 2009 and 2010, particularly in the Hoggar (Oued El Botha: 26 31 N 02 56 E and Oued Amded: 22 48 N 04 18 E), the Adrar region (In Belbel: 28 12 N 01 09 E, 27 33 N 01 12 E, 27 48 N 01 34 E and Zaouiet Kunta: 27 18 N 00 12W, 27 12 N 00 13W), the region of Bechar (Ksabi: 29 07 N 01 05 W).



**Figure 1: Capture Sites Locust in Southern Algeria**

## MATERIALS AND METHODS

### Materials

To examine the phase state of populations of *Schistocerca gregaria* by the calculation of morphometric, we used the following equipments:

- **Material of Capture:** To capture the locusts we used a sweep net.
- **Cages/Boxes:** winged locusts and hoppers caught are put into cages/boxes to be brought to the laboratory for the study.

In the laboratory, the material used for the study of morphometric indices is composed of:

- A caliper
- Graphic paper
- A stereoscopic microscope or a magnifying binocular glass

### Methods

- **The Selection of the Study Sites in the Field**

Site selection was made according to the presence of the locusts localized by the monitoring locust teams of the National Institute of Plant Protection of Algeria (INPV) during the control campaigns of 2009 and 2010 (Figure 1)

- **The Capture of Locusts**

To capture the winged across the fields, we used the technique of sweep net, which remains the most practical and efficient. It consists to capture randomly individuals, with a net-sweep, assisted by a people pushing locusts in the direction of the net holder (Figure 2). With a quick glance it is oriented towards the flying insect so that it penetrates deeply into the cone. The catches were performed outside hot periods of the day, in the morning between 8am and 11am and in the

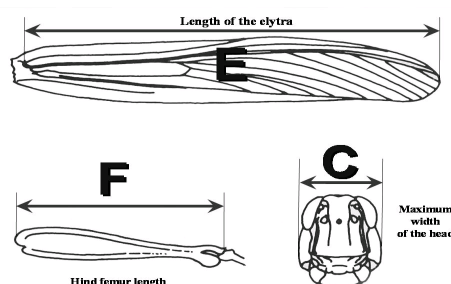
evening between 4 pm and 6 pm. In the whole of the stations, capture was performed on an area of 10,000 m<sup>2</sup>.



**Figure 2: The Method of Capture Adults on Ground**

- Laboratory Manipulations**

The measurements were made with an electronic caliper, measuring different parts of the insect body, particularly the length of the elytra, hind femur length and maximum width of the head. Also, calculations of E / F and F / C ratios were performed for each locust. (Figure 3 and 4).



**Figure 3: Parts of the Body Used for Morphometric Measurements**



**Figure 4: Using the Caliper for the Various Morphometric Measurements**

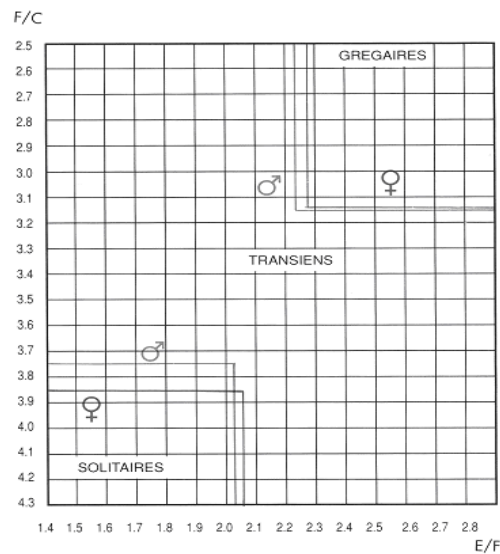
## REFERENCE TABLE OF DIRSH (1953)

To set the phase status of the captured locusts in the study sites, we used the morphometric ratios of reference given by Dirsh (1953), cited by Doumandji-Mitiche and al. 1996. (Table 1)

**Table 1: Indices of *Schistocerca gregaria* Morphometric According to Dirsh (1953)**

	Solitary		Transient		Gregarious	
	Males	Females	Males	Females	Males	Females
<b>E/F</b>	1,99-2,07	2,02-2,09	2,08-2,13	2,10-2,15	2,14-2,28	2,16-2,33
<b>F/C</b>	3,80-3,95	3,87-4,04	3,62-3,79	3,71-3,86	3,03-3,61	3,05-3,70

## MORPHOMETRIC ABACUS OF DURANTON AND LECOQ (1990)



**Figure 5: Abacus Morphometric (Changes from Rungs, 1954) in (Duranton and Lecoq, 1990)**

This method uses a graphic representation of the morphometric ratios of the individuals studied. According to their position in the chart, we can determine the phase state of the locust and its tendency towards one of the two phases (Figure 5).

## DATA ANALYSIS

The main component analysis is used to provide data described by a large number of quantitative variables planar representations (and thus visually interpretable) as accurate as possible. For this, the data is projected onto the factorial designs; each plane being defined by a pair of principal components taken from the first main component. From the review of these projections, the analyst will try to retrieve information on the data structure. These data may be derived from a sampling procedure or observation of an entire population. Representations of the units allow describing the distribution of individuals in the space and also finding the main axes that absorb maximum inertia of clouds and finally, his great interest is obtaining graphical summaries of the results.

## RESULTS

### According to the Morphometric Ratios of Reference Dirsh (1953)

The following table shows a summary of the results related to averages of the morphometric ratios of individuals captured at 08 sites in the Algerian Sahara in the two years 2009 and 2010. (Tab.1)

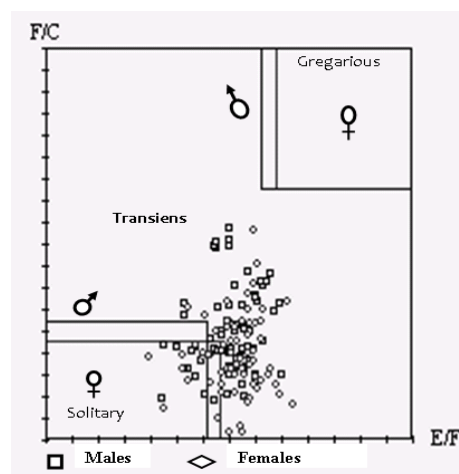
**Table 2: Comparison of the Average Results E / F Ratios and F / C with those of Dirsh (1953)**

Wilaya (Province)	Capture Sites	Number of Individuals (Gender and Number)	E/F (Status)	F/C (Status)
Tamanrasset	Oued El Botha (mai 2009) 26 31 N 02 56 E	Males (8)	(2,13± 0,07) <b>Transiens</b>	(3,87 ± 0,17) <b>Solitaire</b>
		females (13)	(2,09 ± 0,09) <b>Solitaire</b>	(4,03 ± 0,14) <b>Solitaire</b>
	Oued Amded (novembre 2010) 22 48 N 04 18 E	Males (10)	(2,06 ± 0,07) <b>Solitaires</b>	(3,95± 0,09) <b>Solitaire</b>
		Females (10)	(2,12± 0,10) <b>Transiens</b>	(3,95± 0,13) <b>Solitaire</b>
Adrar	Nord In Belbel (mai 2009) 28 12 N 01 09 E	Males (20)	(2,13 ±0,08) <b>Transiens</b>	(3,86 ± 0,14) <b>Transiens</b>
		Females (14)	(2,13 ± 0,10) <b>Solitaire</b>	(4,00 ± 0,27) <b>Solitaire</b>

	<b>Sud In Belbel (mai 2010)</b> 27 33 N 01 12 E	Males (10)	(2,12 ± 0,03) <b>Transiens</b>	(3,86 ± 0,12) <b>Solitary</b>
		Females (10)	(2,15 ± 0,04) <b>Transiens</b>	(3,97 ± 0,06) <b>Solitary</b>
	<b>Est In Belbel (mai 2010)</b> 27 48 N 01 34 E	Males (9)	(2,00 ± 0,11) <b>Solitaire</b>	(3,83 ± 0,21) <b>Solitary</b>
		Females (9)	(2,10 ± 0,13) <b>Transiens</b>	(3,85 ± 0,21) <b>Solitary</b>
	<b>Zaouiet Kounta (mai 2009)</b> 27 18 N 00 12W	Males (10)	(2,02 ± 0,10) <b>Solitaire</b>	(3,65 ± 0,21) <b>Transiens</b>
		Females (10)	(2,09 ± 0,05) <b>Solitaire</b>	(3,83 ± 0,16) <b>Transiens</b>
	<b>Zaouiet Kounta (Mai 2010)</b> 27 12 N 00 13W	Males (10)	(2,13 ± 0,05) <b>Solitaire</b>	(3,93 ± 0,27) <b>Transiens</b>
		Females (10)	(2,12 ± 0,11) <b>Transiens</b>	(3,83 ± 0,16) <b>Transiens</b>
<b>Béchar</b>	<b>Ksabi (Avril 2010)</b> 29 07 N 01 05 W	Males (4)	(2,03 ± 0,05) <b>Solitaire</b>	(3,87 ± 0,35). <b>Solitary</b>
		Females (6)	(2,13 ± 0,12) <b>Transiens</b>	(3,87 ± 0,17) <b>Solitary</b>
<b>Total Individuals</b>		<b>Males (81)</b>	<b>Females (82)</b>	

### According to the Morphometric Standard Chart

The graph at the morphometric standard abacus of the captured locusts in the various study stations between 2009 and 2010, shows that they have a transient status with a tendency towards the solitary phase (transient dissocians). (Figure 6)



**Figure 6: Graphical Representation in Standard Abacus Morphometric of All Locust Individuals Captured in Southern Algeria during 2009 -2010**

### DISCUSSIONS

During various surveys carried out during the two years 2009 and 2010, we collected 163 individuals, including 81 males and 82 females. The mean values of morphometric ratios on Elytra/ Femur (E / F) and Femur/Cephalic capsule (F / C) in the 8 study sites fluctuate in males from 2.02 to 2.13 for the E / F ratio and 3.65 to 3.95 for the F / C ratio. For females E / F varies from 2.09 to 2.15 and F / C varies from 3.83 to 4.03 (Table 1). Referring to the Dirsh scale (1953) and standard morphometric chart, it appears that locust populations of both sexes evolving in different Saharan regions (central and southern) are mostly transient with Solitary trend given that the catches were performed during a calm phase and in biotopes characterized by dense vegetation, which prevents the grouping of the locusts.

We also have frankly solitary individuals but with relatively very small numbers and a total absence of gregarious. This can be justified by the low densities of locusts in infested areas between 2009 and 2010 and which quasi-totality did not exceed 2,000 individuals per hectare i.e. 0.2 individuals/m<sup>2</sup>. The implementation of the Main Component Analysis (ACP) for individuals captured in different Saharan regions during the years 2009 and 2010 shows that the ratio of E / F and F / C change conversely with respect to the other. The percentages of the two inertia axes considered as expressing the contribution rates are 50.98% for axis 1 and 26.84% for axis 2. For the percentage contribution of each variable Femur (F) Elytra (E), cephalic capsule (C) and morphometric ratios E/F and F / C in the formation of axes, the femur variable contributes most to the formation of axis 1 with a rate of 36.43 %. It is followed by the Elytra variable (33.3%). On the other hand for axis 2, the E / F is one that contributes the most (45.04%). Followed by F / C ratio (42.27%). For percentages of overall inertia for both axes, the contribution rate are 50.98% for axis 1 and 26.84% for axis 2.

The spatial representation of the whole male individuals and females captured following variables and ratios indicate that this population is heterogeneous with both solitarious and transient character. Several national and foreign authors worked on morphometric characteristics in the Southern Algeria. We can mention those made by Volkonsky (1939, 1940 and 1942) where he reported that the locust populations present in the central Sahara between 1939 and 1941 were populations with solitary status. Seddik (1995) noted that locust populations studied in Adrar have a transient status. The same result was noted by Ouchen (1995) in the region of Tamanrasset.

The work done by Kara (1997) between 1993 and 1995 in the Adrar region showed that the populations studied were similar to the transient state. Doumandji-Mitiche & al. (1996). during the upsurge period of locust in Algeria in the regions of Tamanrasset and Adrar in 1995 reported the presence of dissocians transient populations. The same study by Khider (1999) in the region of In Salah in 1995 revealed the presence of locust populations with transient congregans status. The same author has indicated in its biometric study of locust populations in three stations Adrar, Bâamor, Aoulef and Zaouiet Kunta, showed a transient status. Sellam (1997) also noted in his study in Saoura region the presence of locust with congregans transient status. Cherief (2000) observed in the Adrar region in 1996 and 1998, locust populations consisting mostly in dissocians transient individuals. Guendouz-Benrima (2005) through his study of the distribution of locust populations in the south of Algeria between 1994 and 1998, noted that the sampling of locust populations in different biotopes in southern Algeria showed that homogeneous solitary populations and heterogeneous of solitary-transient and solitary-transient-gregarious populations, are distributed among the different areas of central and southern Sahara during two periods of the year, in spring and autumn. Kaidi (2006) reports in his morphometric study of the Desert Locust in the Hoggar in 2006 that the populations studied were transient with the presence of some solitary individuals, and probably some gregarious individuals from residual populations of post invasion. Kherbouche (2007) in his morphometric study of locust during the invasion in 2004 in Adrar region indicates that the sampled population has a gregarious status. Bensalah (2009) indicates that locust populations in the region of Biskra during the invasion in 2004 were gregarious.

## CONCLUSIONS

The different diagrams performed from morphometric measurements made on 81 males and 82 females coming from catches during the years 2009 and 2010 in eight biotopes of the central Sahara and one in the southern Sahara, suggest that male and female populations evolving in both southern and central parts of the Algerian Sahara for the two years 2009/2010 are mostly Solitary-Transiens.

We also have frankly solitary individuals but with relatively low numbers and a total absence of gregarious individuals.

## REFERENCES

1. **BENSALAH M. K. 2009**, *Etude de quelques aspects bioécologiques du criquet pèlerin Schistocerca gregaria (Forskål, 1775) (Orthoptera, Acrididae) durant l'invasion 2004-2005 dans la région de Biskra*. Thèse de Magister en sciences agronomiques, Inst. Nat. Agro. El Harrach, 150 p.
2. **BOUAICHI A. & SIMPSON J, 2003** – Density-dependant accumulation of phase characteristics in natural population of the desert locust *Schistocerca gregaria*. *Physiological entomology*, (28): 25 – 31.
3. **CHARA B, 1995c**, Eléments sur la biologie et l'écologie du criquet pèlerin *Schistocerca gregaria* (Forskål, 1775). Stage de formation en lutte antiacridienne. 17 – 27 septembre 1995, INPV-OADA, El Harrach, Alger, :32-45.
4. **CHARA B. 1998**, *Organisation de la lutte antiacridienne en Algérie*. Historique et évolution des moyens- CLCPANO: Alger: 53p.
5. **CHERIEF A, 2000** - *Etude bio- écologique du criquet pèlerin Schistocerca gregaria (Forskål, 1775) (Acrididae, Cyrtacanthacridinae) dans la région d'Adrar. Etude de la morphométrie, du régime alimentaire sur terrain et du photo-préférendum alimentaire au laboratoire*. Thèse Magister scien. agro, Inst. nati. agro, El Harrach, 135 p.
6. **DIRSH V. M, 1953** – Morphometrical studies on phases of the desert locust (*Schistocerca gregaria*, Forskal). *Anti-locust bull*, (16): 1-34.
7. **DOUMANDJI-MITICHE B, DOUMANDJI S, SEDDIK A. et OUCHEN D, 1996** - Comparaison des indices morphométriques de la sauterelle pèlerine *Schistocerca gregaria* à Adrar et Tamanrasset (Sahara, Algérie). *Med. fac. Landbouww, Univ. Gent*, 61, (3a): 777 – 780.
8. **DURANTON J.-F. & LECOQ M, 1990**. - *Le Criquet pèlerin au Sahel*. -Coll: *Acridologie opérationnelle*, n° 6 - CILSS-DFPV / Ministère des Affaires Étrangères des Pays-Bas / CIRAD-GERDAT-Prifas: Niamey / La Haye / Montpellier. – 183.
9. **ENCARTA 2009** – Carte géographique de l'Algérie. Ed. Encarta, 1p.
10. **HAMDINE O, 2001**- *Conservation du Guépard (Acinonyx jubatus Schreber, 1776) de la région de l'Ahaggar et du Tassili n'Adjer en Algérie*- Programme U.I.C.N. pour l'Afrique du Nord, Tamanrasset, 50 p.
11. **KAIDI N, 2006**– *Bioécologie de Schistocerca gregaria Forskål, 1775 (Orthoptera, Cyrtacanthacridinae) dans la région de l'Ahaggar. Essai de lutte biologique au moyen de champignons entomopathogènes: Beauveria bassiana et Methrizium anizopliae var. acridum* Thèse Magister, Inst. nati. agro, El Harrach, 162p.
12. **KARA F.Z, 1997** - *Etude de quelques aspects écologiques et régime alimentaire de Schistocerca gregaria (Forskål, 1775) (Acrididae, Cyrtacanthacridinae) dans la région d'Adrar et en conditions contrôlées*. Thèse Magister, Inst. nati. agro, El Harrach, 182 p.

13. **KERBOUCHE Y, 2007-** *Etude de quelques aspects bioécologiques et régime alimentaire de Schistocerca gregaria (Forskål, 1775) (acrididae. Cyrtacanthacridinae) dans la région d'Adrar (Sahara, Algérie).* Thèse de Magister en sciences agronomiques, Inst. Nat. Agro. El Harrach, 155 p.
14. **KHIDER B, 1999 –** *Biométrie et régime alimentaire et répartition des zones de reproduction du criquet pèlerin Schistocerca gregaria (Forskål, 1775) (Orthoptera, Cyrtacanthacridinae), au sud Algérien.* Thèse Magister agro, Inst. nat. agro, El-Harrach, 142p.
15. **MOUMEN K, 1997,** *La transformation phasaire chez le criquet pèlerin, Schistocerca gregaria (Forskål, 1775). Mécanisme et action de l'alimentation.* Mémoire de D.E.A. en Ecologie Animale. Faculté des sciences de Tunis: 36p.
16. **UVAROV B.P. 1977.** *Grasshoppers and locusts.* Vol 2. Cambrid University Press Cam-bridge, 613 pp.
17. **VOLKONSKY M.A 1942.** Une mission d'étude de Schistocerca gregaria (Forskål), phase solitaire dans le Sahara central (Hoggar, Assegrad, Ahnet) novembre - décembre 1940. (Quatrième rapport préliminaire) Arch. Inst. Pasteur d'Algérie, 19 (2): 313-325.
18. **VOLKONSKY M.A et VOLKONSKY M.T, 1939.** Rapport préliminaire sur une mission d'étude des acridiens dans le Mouydir et le Tademaït (Mai-juillet 1939): Arch. Inst. Pasteur Algérie, 17(4) 634-649, 1 map.
19. **VOLKONSKY M.A et VOLKONSKY M.T, 1940.** Quatrième rapport préliminaire. Une mission d'étude de Schistocerca gregaria (Forskål) dans le Sahara central algérien: Hoggar, Ahnet, Assegrad. Décembre 1940. Arch. Inst. Pasteur Algérie, 19 (2).